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(71)(72) Applicant and Inventor: COPP, Douglas, F. [US/US]; Copp Life Systems, P.O. Box 489, Alameda, CA 94501 (US).

(74) Agent: KELLY, Patrick, D.; 707 Creekbriar Lane, St. Louis, MO 63122-2221 (US).

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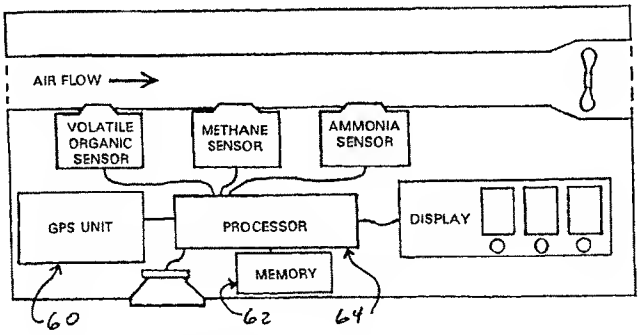

(57) Abstract

A portable, hand-held device for locating the remains of a corpseby sensing a combination of volatile gases which are released during bacterial decomposition of human tissue. One such combination of volatile gases includes methane, ammonia and a volatile organic compound, such as a ketone that is released when livers decompose. The portable device comprises: a combination of commercially available sensors (14, 16, 18) which can detect these chemicals in parts per million concentrations; an air conduit (22) with a fan (20) to draw ambient air across the sensors (14, 16, 18); and various types of alarm/visual indicators (42, 44) to alert an operator the detection of all three gases which may indicate the location of probable decomposing corpse hidden in the water, mud, rubble, soil or other coverings, at or nearby. The device can also include a global positioning system (60) to ascertain the exact location.

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METHOD AND APPARATUS FOR LOCATING HIDDEN CORPSES BY DETECTING VOLATILE GAS COMBINATIONS

FIELD OF THE INVENTION

The invention involves a method and apparatus for locating a corpse (especially a human corpse) after a drowning, building or mine collapse, mudslide, earthquake, or similar accident or disaster, or after a murder. This is accomplished by using portable sensors which can detect a combination of volatile chemicals that are generated and released during bacterial decomposition of tissue.

BACKGROUND OF THE INVENTION

Conventional methods for locating the corpses of people who have died as a result of an accident, disaster, or crime have been inefficient, time-consuming, and non-automated, and frequently require extensive manpower. For example, searches for drowning victims submerged in lakes or other bodies of water have been conducted by time-consuming and/or inaccurate methods such as physically "dragging" the bottom using snaring devices, and by visual inspection by teams of divers (who must be supported by personnel and watercraft on the surface). These are occasionally supplemented by sonar-type and other electronic devices operated from surface craft, but such devices usually can only try to locate solid debris which might indicate the presence of a corpse nearby (such as the wreckage of a plane or boat), or they require clear water to function properly for visual inspection using a video-type monitor which remains on the surface. It is common for submerged victims of boating accidents, or airplanes which have crashed into water, to be located only after extended, costly, time-consuming searches, and many such victims are never located.

Similarly, a search for a murder victim who may have been buried in a shallow grave typically requires prolonged and tedious efforts, which severely distract and divert the time and attention of law enforcement officials, family members, and others. Even when human searchers are accompanied by dogs trained to employ their sense of smell to locate corpses, such searches are usually difficult, protracted, and often unsuccessful.

Accordingly, one object of this invention is to disclose a faster, more accurate, more efficient method for locating the remains of people who have been killed in accidents (such as drowning victims who are submerged in lakes, oceans, or other bodies of water) or disasters (such as buried victims of mine collapses, earthquakes, mudslides, floods, etc.), or who are victims of crimes such as kidnaping and murder.

Another object of this invention is to disclose a method and device for locating decomposing remains of people by employing a selection of chemical sensors to detect the simultaneous presence of at least three volatile chemicals that are released by bacterial decomposition of tissue, in the ambient air above the water, soil, or rubble which hold the remains of the person who died.

Another object of this invention is to disclose a device for locating the decomposing remains of accident, disaster, or crime victims, which contains a proper selection of chemical sensors that have been combined with each other, and with alarm-type indicators and certain other components, in a convenient, hand-held, battery-powered portable device that can easily be used in the field by a single operator who has been properly trained in the use of the device.

These and other objects of the invention will become more apparent through the following summary, drawings, and description of the preferred embodiments.

SUMMARY OF THE INVENTION

This invention discloses a portable, hand-held device to assist in locating the remains of people who have been killed in accidents, disasters, or crimes. This device works by sensing a combination of volatile gases which are released during bacterial decomposition of tissue. One such combination of volatile gases includes methane, ammonia, and a volatile organic compound such as a ketone. Portable sensors which can detect each of these chemicals in ambient air at "parts per million" (ppm) levels are known and are commercially available. These have been developed for safety purposes such as fire prevention, and to reduce the exposure of people and sensitive manufacturing processes to potentially harmful chemicals; they have not previously been used to locate decomposing corpses. Each chemical sensor is coupled to at least one type of output indicator which can generate a signal, such as a horn, siren, flashing light, or a visual display such as a digital or analog readout. The portable unit preferably should be battery-powered, and preferably should contain an air conduit with a fan, so that it can draw ambient air across the sensor

surfaces, for improved detection of the volatile gases. During a search operation, the device is carried and moved around the general area above the location where a corpse is suspected of being hidden; for example, it can be held by an operator on the deck of a boat, preferably upwind of the boat's engine exhaust outlet, as the boat traverses the area being searched. When a first signal output (preferably a loud audio signal, such as a horn or siren) indicates that a peak reading of a volatile organic compound such as a ketone has been detected, the operator can inspect the visual display outputs from the methane and ammonia sensors. If the outputs of all three sensors indicate elevated levels of all three volatile compounds in the ambient air at a certain location, the combination of all three gaseous compounds indicates a strong likelihood that a decomposing corpse is hidden in the water, mud, rubble, soil, or other material at or near that location. If desired, the portable device can also contain a locating component, such as a "Global Positioning System" (GPS) unit which can receive and process GPS satellite transmissions, and a recording or printing component, to make it easier for the operator to record the exact location where the elevated gaseous readings occurred.

This invention also discloses a method for searching for and locating a decomposing corpse, using a combination of portable sensors which can detect ppm levels of selected volatile gases in ambient air, as described above.

A preferred method relies on the location of "peak" readings (which occur when a local maximum concentration of a certain gas, in ambient air, begins to decline), rather than relying on absolute concentrations or threshold values. Because numerous uncontrollable factors alter and distort the absolute concentration of each volatile gas in the vicinity of a decomposing corpse, it has been found that peak concentrations provide better and more reliable indicators than absolute concentrations. Accordingly, the locating device disclosed herein preferably should include one or more microprocessor controls that can generate output signals to indicate the presence of peak gas concentrations, regardless of the absolute concentrations of those gases.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a block diagram of a locator device as disclosed herein, showing three volatile gas sensors (for methane, ammonia, and a volatile organic compound) combined in a holding device which contains an air conduit and a fan to draw ambient air through the device, and having electronic signal-processing components.

FIGURE 2 is a block diagram of a locator device as shown in Fig. 1, which also contains a "Global Positioning System" (GPS) unit to indicate the locations where peak readings of the volatile gases are encountered.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings more particularly by reference numbers, number 10 in Fig. 1 refers to a portable sensing device according to the present invention. This sensing device 10 includes a housing 12 which encloses volatile gas sensors 14, 16, and 18.

Housing 12 also contains a blower device 20 (this term is used herein to include a fan blade, a compressor, a gas-pumping scroll device, or any other pumping device which is suitable for moving air through a conduit) which draws ambient air into and through an air conduit 22, via air inlet 22a and outlet 22b. While passing through conduit 22, the air contacts the exposed detector surfaces of the gas sensors 14, 16, and 18, which are mounted in the housing frame 12 in a manner causing their detector surfaces to be directly exposed to air passing through the conduit 22.

Housing 12 also contains a signal processor 30 which is coupled to a loudspeaker or horn 32 and a display unit 40. Housing 40 preferably should be equipped to hold batteries, or to be coupled to some other suitable power supply, to drive the electronic components of the device.

In a preferred embodiment illustrated in Fig. 3, display unit 40 contains three digital readouts (or analog dials) 42, each of which can indicate the concentration of one of the three volatile gases being measured. Display unit 40 also contains three alarm indicators 44, each of which can be programmed to emit an alarm signal (such as a blinking light, or a beeping, warbling, or similar noise) when a condition of interest is detected by the sensor which detects the corresponding volatile gas. Various display and alarm options are discussed in more detail below.

The preferred selection and combination of three different volatile gases which are detected by a gas detection unit as disclosed herein can be varied if desired, so long as each of the three selected volatile gases is generated and released in substantial quantities during bacterial decomposition of dead tissue. Tests by the Inventor, using animal corpses as well as actual use in locating human corpses after drowning accidents, have indicated that a combination of detectors which can sense methane, ammonia, and at least one volatile organic compound (preferably at least one ketone of the type which are generated during

decomposition of human livers) provides excellent results.

The term "volatile organic compound" (abbreviated herein as VOC) is used in its usual sense, but is limited herein to exclude methane, ethane, and carbon dioxide. The word "organic" indicates that a VOC contains carbon atoms; the word "volatile" indicates that it has a vapor pressure of at least about 0.1 millimeters of mercury at typical ambient temperatures.

It should be noted that carbon dioxide (CO_2) is a volatile organic compound. If desired, locator devices containing CO_2 sensors can be tested, under field conditions, to evaluate their suitability for use as disclosed herein. However, CO_2 sensors were not selected and are not preferred for use in locators as disclosed herein, since they are believed to be much more likely to suffer from unwanted positive readings, when compared to sensors designed to detect other, less common volatile organic compounds, such as the types of ketones generated by decomposing livers. If CO_2 detectors are used, interference from ambient sources of CO_2 are highly likely, since CO_2 is a byproduct of breathing and of any internal combustion engine, and is also a natural component of ambient air.

Suitable gas detectors which can detect "ppm" (parts-per-million) levels of each of the three volatile gases preferred herein (methane, ammonia, and ketones of the type generated during decomposition of livers) are commercially available, and are manufactured by several companies. As one example, Crowcon Detection Instruments Ltd. (Oxfordshire, United Kingdom and Milford, Ohio; www.crowcon.com) manufactures all three detectors. These can be installed, as interchangeable modules, in a frame and housing unit which also contains an air conduit and fan device, and a fairly sophisticated microprocessor and display/alarm system, in a device which is called the "TRIPLE PLUS" system by Crowcon. This system, and a wide array of interchangeable detector components which can be selected as desired and installed into the system by anyone who purchases one of these units, were initially developed for purposes such as fire prevention, hazard control, and quality control during chemical-sensitive manufacturing operations; to the best of the Applicant's knowledge and belief, these systems have never previously been used for the purpose of locating decomposing corpses.

Other companies are believed to manufacture equally suitable gas-sensing components, which can be installed interchangeably into a housing frame that is also provided with an air sampling conduit and fan and with microprocessor controls and display/alarm components. Such companies include Aim-Safe, Inc. (Austin, Texas;

www.aimsafety.com), and English Electric Valve, Ltd. (Essex, United Kingdom, and Toronto, Canada; www.eev.com).

Still other companies also manufacture various other types of gas detectors include Draeger Safety Inc. (Pittsburgh, Pennsylvania; www.drager.com or www.draeger-usa.com), Spectrex Inc. (Cedar Grove, NJ; www.spectrex-inc.com), Environmental Monitoring Systems Inc. (Columbus, Ohio; www.emss.net), and North American Detectors Inc. (Toronto, Canada). Although it is not known whether these companies currently manufacture portable sensors having ppm sensitivity levels for methane, ammonia, and VOC's, any company which sells a line of gas detectors, and which has well-established research and manufacturing expertise in gas detectors, can develop ppm-sensitive sensors for methane, ammonia, and VOC's, using known technology with no more than routine experimentation.

OUTPUT, DISPLAY, AND ALARM OPTIONS

Display unit 40 can comprise any suitable type of signal-generating display device which can be interpreted by a human operator, and which can indicate absolute or peak concentrations (which will vary, depending on time and location) of a volatile gas of interest.

For example, a panel of three digital numerical displays 42 can be provided, as illustrated in Fig. 1, wherein each display indicates the concentration of a certain volatile gas being measured by a corresponding sensor. Alternately, analog devices can be used, in which a needle moves across a scale in a dial-type device. As another alternative, a row of lights (preferably using light-emitting diodes, LED's, which require less electrical power than conventional bulbs) can be used, wherein the number of LED's or bulbs which are lit at a given moment indicate the strength of the signal.

Alternately or additionally, an audible signal (such as a beep, horn, or siren) or similar alarm-type signal, corresponding to each gas being measured, can be generated by means of three alarm devices 44, as shown in Fig. 1.

Preferably, at least one relatively loud audible alarm should be provided, such as by means of loudspeaker 32, to minimize the risk that a human operator might fail to notice an important reading. In actual usage, it has been found that if a single audible alarm is provided (which can be activated, in one preferred embodiment, by the VOC sensor), it will reliably alert the operator to pay careful attention to any visual displays on the device,

in a manner which will lead rapidly to a successful conclusion of the search if indeed the locator has approached the general location of a hidden corpse. In addition, if an operator hears an audible alarm, he can, if appropriate, slow down the speed at which the device is being moved, and take any other suitable precautions. For example, if the device is being carried on a boat, the boat can be slowed down, and the operator can lean over a railing and extend his arms downward, to hold the device closer to the water surface. If the search is on land, an operator who is walking and carrying the device can kneel down and hold the device close to the soil, rubble, or other surface material while he sweeps it across the surface area being examined.

In an alternate preferred embodiment, the volume (loudness), pitch, or other variable trait of one or more audible signals can be used to indicate the strength of a reading (such as the absolute concentration of a gas, or the existence of a peak concentration of a gas). As an example, the three gas sensors can be coupled to three different horns or other audible alarms which have different and preferably dissonant pitches. This approach may be preferable, for example, for a person who is steering a small boat or walking across an uneven and potentially dangerous surface while also trying to monitor the signals and outputs of the device.

Alternately or additionally, since localized peak concentrations of each gas are highly important, an alarm-type output (such as a loud siren or horn) can be programmed to be emitted in a loud, warbling, intermittently beeping, or otherwise distinct manner if and when a peak gas concentration has been detected. Peak readings are qualitative; a peak reading either does or does not exist, at a specific location. Since absolute concentration levels are highly variable and are heavily affected by weather and other factors during a search, a peak alarm preferably should be qualitative (i.e., on/off) rather than quantitative.

During operation, processor 30 continuously processes the output (or samples of the output, taken periodically) of each of the three gas sensors 14, 16, and 18. Upon detection of a localized peak concentration (i.e., when the output of a sensor begins to decline, after reaching a local maximum), processor 30 asserts a set of one or more alarm signals. In response to the alarm signal(s), loudspeaker 32 emits sound, and the alarm component 44 which corresponds to that specific gas emits a signal such as a blinking light or beeping noise.

The processor 30 continues to process the outputs (or samples of the outputs) of sensors 14, 16, and 18, and causes display unit 40 to display continuously or frequently

updated indications of the output signal from each of the three gas sensors. The user responds to the audible or visual alarm by reading the sensor output level displays on display unit 40, to determine whether and when the outputs of all three gas sensors 14, 16, and 18 indicate the presence of all three volatile gases that are being measured. If all three sensors indicate that all three measured gases are present in elevated concentrations, and especially if the display 40 indicates concentration peaks for all three gases in a single relatively small local area, the operator interprets the combined results of all three indicators as indicating a high likelihood that a decomposing corpse is located either: (1) directly below the location where the peak readings are highest, or (2) in a location which is roughly below the location where the peak readings are highest, and which is adjusted to accommodate for local factors (underwater currents, breezes or winds in the area, etc.) which would affect the travel path of gaseous bubbles or molecules which are rising through water, mud, rubble, or other material which covers and hides the decaying corpse.

Typically, the locating device disclosed herein will be used to help recovery workers identify one or more probable and productive locations where they should begin searching for a corpse. For example, a locator carried on a boat on a lake or ocean surface typically will indicate where scuba divers should begin looking for one or more corpses on the lakebed or ocean floor. A locator device used on land typically will indicate where workers (using tools such as shovels and picks, and possibly using heavy equipment such as backhoes, bulldozers, etc.) should begin digging, tunnelling, or carrying out similar operations to uncover a buried corpse.

The sensors of a locator device as disclosed herein need not be mounted in any particular physical sequence or arrangement, so long as the detector surfaces are exposed to ambient air (preferably, air which is being drawn through an air conduit by an active fan device). In variations on the Fig. 1 embodiment, a single sensor performs the function of two or more of sensors 14, 16, and 18. In other implementations of the invention, two or more sensors are employed to sense different VOC's or classes of VOCs (rather than a single sensor such as sensor 14 of Fig. 1). For most applications, it is sufficient for each sensor of this device to have 1 ppm ("part per million") resolution; however, even lower resolutions can be used, if desired.

In variations on the Fig. 1 apparatus, the apparatus of the invention is used with a GPS system (or other positioning system). The user can manually log position data (output from the positioning system) which indicates the position (latitude and longitude) of the

inventive chemical sensing apparatus each time that a corpse is located.

A locator device which does not contain a GPS-type positioning unit, to determine the precise location of the device when it encounters peak readings indicating a corpse, will be adequate in nearly all situations. In boats, GPS devices have become extremely common. Therefore, when a corpse locator is being used on the surface of a lake or ocean, the person who is handling the locator can use vocal communication or hand signals to indicate peak readings to another person who is in a cabin, bridge, or other sheltered location where the GPS device is located. When the person next to the GPS receives a handwave or other signal, he or she simply records the location indicated on the GPS at that moment.

On land, a digging or tunnelling operation usually is commenced as soon as the likely location of a corpse is determined, so typically, there is no need to record the coordinates of the location for subsequent use. In addition, most land operations are sufficiently close to various landmarks to allow an operator to make descriptive notes, which can subsequently be used to determine a preferred location fo a digging or tunnelling operation.

Alternately or additionally, a portable hand-carried GPS system can be easily purchased as a separate unit, and carried alongside a corpse locator device as disclosed herein. The location indicated by the accompanying GPS device can be written down by any trained operator, if and when the signals from a locator indicate that a decomposing corpse is likely to be hidden somewhere below that position.

Nevertheless, if desired, a GSP unit or other position-identifying device can be incorporated into a corpse locator system as disclosed herein. Such a locator device 70 is illustrated in FIG. 2, which illustrates an electronic GPS subsystem 60 (i.e., a positioning subsystem which is configured to receive and process satellite transmissions and generate therefrom position data which indicates the location of the apparatus). This locator device 70 also includes an electronic memory register 62. The GPS unit 60 and the memory register 62 will each interact with electronic processor 64. Processor 64 will handle the same functions as processor 30, but which will also require additional functions which are necessary for processor 64 to interact with the GPS unit 60 (to determine the positional reading of the GPS unit 60 (preferably at each moment when a control button or switch is actuated by the operator, to record the coordinates of a site) and with the memory register 62 (to cause register 62 to enter, store, and subsequently retrieve positional data generated by the GPS unit 60). All other components shown in Fig. 2 have the same layout and

function as the system illustrated in FIG. 1. If desired, a memory register 64 can be provided within the circuitry of processor 64, in a manner analogous to providing cache memory in a computer processor.

Accordingly, when rephrased in language suitable for a patent claim, this invention discloses a portable locating device for locating hidden decomposing corpses, comprising (a) a portable housing; (b) a plurality of chemical sensors mounted in the housing, wherein the sensors, acting together, have been selected to detect at least three volatile gases in ambient air, wherein each of said three volatile gases is generated and released in substantial quantities during bacterial decomposition of human tissue, and wherein each chemical sensor is designed to emit an electronic signal when one of said three volatile gases is detected by one of said chemical sensors; (c) an electronic processor coupled to the housing and capable of receiving electronic signals from the sensors, wherein the processor is configured to generate an output signal set which indicates sensing of all of three volatile gases in ambient air, in a single location; and, (d) at least one output device which emits a signal or combination of signals that can be interpreted by a human operator as indicating decomposition of a corpse in a hidden location positioned below the ambient air being tested; wherein, the plurality of chemical sensors is selected to detect a combination of volatile gases which, if present in ambient air at a single location, indicate decomposition of a corpse at a hidden location positioned below the ambient air being tested.

METHODS OF USE

In addition to the device described herein, this invention also discloses a method of searching for complete or partial corpses which are hidden and decomposing. One preferred method uses one or more chemical sensors (preferably but not necessarily housed together in a single housing unit, such as disclosed herein) which, acting together, are capable of detecting, at ppm levels in ambient air, each of three selected volatile gases which are generated and released in substantial quantities during bacterial decomposition of dead tissue. A preferred combination of such gases includes methane, ammonia, and at least one volatile organic compound, such as a ketone which is generated during decomposition of human livers.

These chemical sensors are carried or otherwise traversed, while exposed to ambient air, across a region of water or land which is suspected of containing a hidden decomposing

corpse. For example, in marine operations, the sensor can be held or mounted on any suitable surface of a boat which moves across the surface of the water. The boat should move at a suitable speed, such as in the range of about 1 knot up to about 20 knots, or faster if conditions permit. Based on field tests conducted to date, is it believed that a boat carryuing this type of locator device preferably should move through the water at a relatively rapid speed, such as at least about 5 to 10 knots, rather than very slowly, during an initial sweep of the area. This allows the boat to cover more area, and it also appears to enhance the ability of gas sensors to accurately detect local peaks in concentrations of a selected volatile gas.

Under typical conditions, simultaneous detection of methane, ammonia, and a selected volatile organic compound, especially if they are present at peak concentrations in a single localized area compared to the surrounding areas, indicates that a decomposing corpse is likely to be located below the boat (or in a generally ascertainable direction with respect to the boat, considering relevant wind, current, and other conditions).

Preferably, whenever a powered boat or any other powered vehicle is used to carry a locator device, the device should be positioned upwind of the exhaust pipe(s) of the vehicle, and upwind of any other boats, vehicles, or other chemical emitters operating in the vicinity. This will help to locator device avoid obvious chemical emitters that might trigger false-positive identifications of casualty locations.

In one preferred method of this invention, a sensor output which indicates an elevated or peak concentration of a volatile gas in one of the sensed categories (preferably a VOC) is continuously monitored while the locator device is being traversed along a search path. Upon detecting a peak in that volatile gas, the device will issue an audible and/or visible alarm. The user responds to the alarm by checking whether the other sensor outputs indicate the presence of chemicals in both of the other two chemical categories (e.g., ammonia and methane). If so, the user interprets the alarm as indicating a probable location or vicinity of a decomposing corpse. Subsequent search and recovery efforts by divers, diggers, or other workers can then be focused on that location, or on nearby locations which are suggested when relevant modifying factors (such as wind, water currents, and concrete slabs or other inhomogeneities in the rubble of a building collapse) are also taken into account.

When performing a search for buried victims of a disaster such as a mudslide, it is possible that victims are buried beneath a substance such as clay which may be

impermeable to all or some of the gases to be sensed. If it is known or suspected that victim remains are located under such an impermeable layer, an array of holes (along a search path) can be drilled or otherwise formed through the impermeable covering layer. A hose coupled to the air intake of the locator device can then be inserted into each hole to conduct the search. Such holes through an impermeable layer can be formed using an auger, by inserting a pointed pipe which has holes through its sidewall, or by other appropriate means. Using this technique, it may be possible to detect decomposition gases which have entered one of the holes from surrounding permeable material which is located below the impermeable covering layer.

In circumstances with freezing conditions, such as avalanches, it may be difficult to find a victim until thaw and/or decomposition takes place.

Accordingly, when rephrased in language suitable for a patent claim, this invention discloses a method for locating a hidden dead victim of an accident, disaster, or crime, including the steps of (a) monitoring levels of methane, ammonia, and at least one volatile organic compound which is generated and released in a substantial quantity during bacterial decomposition of tissue, in ambient air along a search path, using chemical sensors; and, (b) identifying a surface location which is above and proximate to the location of the hidden dead victim, by sensing all of methane, ammonia, and said at least one volatile organic compound at one location along the search path.

In particular, one preferre dmethod for carrying out the invention comprises the steps of (i) identifying a location of a localized peak in the concentration of one of the three volatile gases being detected, and (ii) determining that both of the other two gases are present in non-zero concentrations at essentially the same location.

Thus, there has been shown and described a new and useful device and method for locating the bodies of accident, disaster, and crime victims. Although this invention has been exemplified for purposes of illustration and description by reference to certain specific embodiments, it will be apparent to those skilled in the art that various modifications, alterations, and equivalents of the illustrated examples are possible. Any such changes which derive directly from the teachings herein, and which do not depart from the spirit and scope of the invention, are deemed to be covered by this invention.

CLAIMS

1. A portable locating device for locating hidden decomposing corpses, comprising:

a. a portable housing;

b. a plurality of chemical sensors mounted in the housing, wherein the sensors, acting together, have been selected to detect at least three volatile gases in ambient air, wherein each of said three volatile gases is generated and released in substantial quantities during bacterial decomposition of human tissue, and wherein each chemical sensor is designed to emit an electronic signal when one of said three volatile gases is detected by one of said chemical sensors;

c. an electronic processor coupled to the housing and capable of receiving electronic signals from the sensors, wherein the processor is configured to generate an output signal set which indicates sensing of all of three volatile gases in ambient air, in a single location; and,

d. at least one output device which emits a signal or combination of signals that can be interpreted by a human operator as indicating decomposition of a corpse in a hidden location positioned below the ambient air being tested,

wherein the plurality of chemical sensors is selected to detect a combination of volatile gases which, if present in ambient air at a single location, indicate decomposition of a corpse at a hidden location positioned below the ambient air being tested.

2. The portable locating device of Claim 1, wherein the plurality of chemical sensors is capable of detecting each of said three volatile gases at concentrations of 1 part per million in ambient air.

3. The portable locating device of Claim 1, wherein the plurality of chemical sensors is selected to detect:

a. methane;

b. ammonia; and,

c. at least one volatile organic compound other than methane, ethane, and carbon dioxide.

4. The portable locating device of Claim 2, wherein at least one chemical sensor is

selected to detect at least one ketone of a type which is released when human liver tissue decomposes.

5. The portable locating device of Claim 1, wherein the chemical sensors are capable of detecting each of said methane, ammonia, and ketone at concentrations of 1 part per million in ambient air.

6. The portable locating device of Claim 3 which also includes an audible alarm device that is programmed to emit an alarm sound, during operation of the portable locating device, when a local peak concentration of a volatile organic compound is detected by a chemical sensor.

7. The portable locating device of Claim 3 which also includes a display panel which indicates, during operation of the portable locating device, concentrations of methane and ammonia which have been detected by the chemical sensors.

8. The portable locating device of Claim 3 which also comprises an air conduit passing through the housing, and a blower device which draws ambient air into and through the air conduit in a manner which causes the air to contact each of the chemical sensors.

9. The portable locating device of Claim 3 which also comprises a positioning subsystem configured to receive and process satellite transmissions and generate therefrom position data which indicates the location of the apparatus.

10. A portable locating device for locating hidden decomposing corpses, comprising:

a. a portable housing;

b. at least one chemical sensor mounted in the housing and capable of detecting methane, ammonia, and at least one volatile organic compound other than methane, ethane, and carbon dioxide, wherein each chemical sensor is designed to emit an electronic signal when one of said three volatile gases is detected by one of said chemical sensors;

c. an electronic processor coupled to the housing and capable of receiving electronic signals from the sensors, wherein the processor is configured to generate an output signal set which indicates sensing of all of three volatile gases in ambient air, in a single location;

and,

d. at least one output device which emits a signal or combination of signals that can be interpreted by a human operator as indicating decomposition of a corpse in a hidden location positioned below the ambient air being tested,

wherein the plurality of chemical sensors is selected to detect a combination of volatile gases which, if present in ambient air at a single location, indicate decomposition of a corpse at a hidden location positioned below the ambient air being tested.

11. The portable locating device of Claim 10, wherein the plurality of chemical sensors is capable of detecting each of said three volatile gases at concentrations of 1 part per million in ambient air.

12. The portable locating device of Claim 10, wherein the plurality of chemical sensors is selected to detect:

a. methane;

b. ammonia; and,

c. at least one volatile organic compound other than methane, ethane, and carbon dioxide.

13. The portable locating device of Claim 11, wherein at least one chemical sensor is selected to detect at least one ketone of a type which is released when human liver tissue decomposes.

14. The portable locating device of Claim 10, wherein the chemical sensors are capable of detecting each of said methane, ammonia, and ketone at concentrations of 1 part per million in ambient air.

15. The portable locating device of Claim 12 which also includes an audible alarm device that is programmed to emit an alarm sound, during operation of the portable locating device, when a local peak concentration of a volatile organic compound is detected by a chemical sensor.

16. The portable locating device of Claim 12 which also includes a display panel

which indicates, during operation of the portable locating device, concentrations of methane and ammonia which have been detected by the chemical sensors.

17. The portable locating device of Claim 12 which also comprises an air conduit passing through the housing, and a blower device which draws ambient air into and through the air conduit in a manner which causes the air to contact each of the chemical sensors.

18. The portable locating device of Claim 12 which also comprises a positioning subsystem configured to receive and process satellite transmissions and generate therefrom position data which indicates the location of the apparatus.

19. A method for locating a hidden dead victim of an accident, disaster, or crime, including the steps of:

(a) monitoring levels of methane, ammonia, and at least one volatile organic compound which is generated and released in a substantial quantity during bacterial decomposition of tissue, in ambient air along a search path, using chemical sensors; and,

(b) identifying a surface location which is above and proximate to the location of the hidden dead victim, by sensing all of methane, ammonia, and said at least one volatile organic compound at one location along the search path.

20. The method of claim 19, wherein step (b) includes the steps of:

(i) identifying a location of a localized peak in the concentration of the volatile organic compound in ambient air; and,

(ii) determining a non-zero concentration of methane and a non-zero concentration of ammonia in ambient air at essentially the same location.

21. The method of claim 19, wherein step (b) includes the steps of:

(i) identifying a location of a localized peak in a detected methane concentration in ambient air; and,

(ii) determining a non-zero concentration of the volatile organic compound and a non-zero concentration of ammonia in ambient air at essentially the same location.

22. The method of claim 19, wherein step (b) includes the steps of:

(i) identifying a location of a localized peak in a detected ammonia concentration in ambient air; and,

(ii) determining a non-zero concentration of the volatile organic compound and a non-zero concentration of methane in ambient air at essentially the same location.

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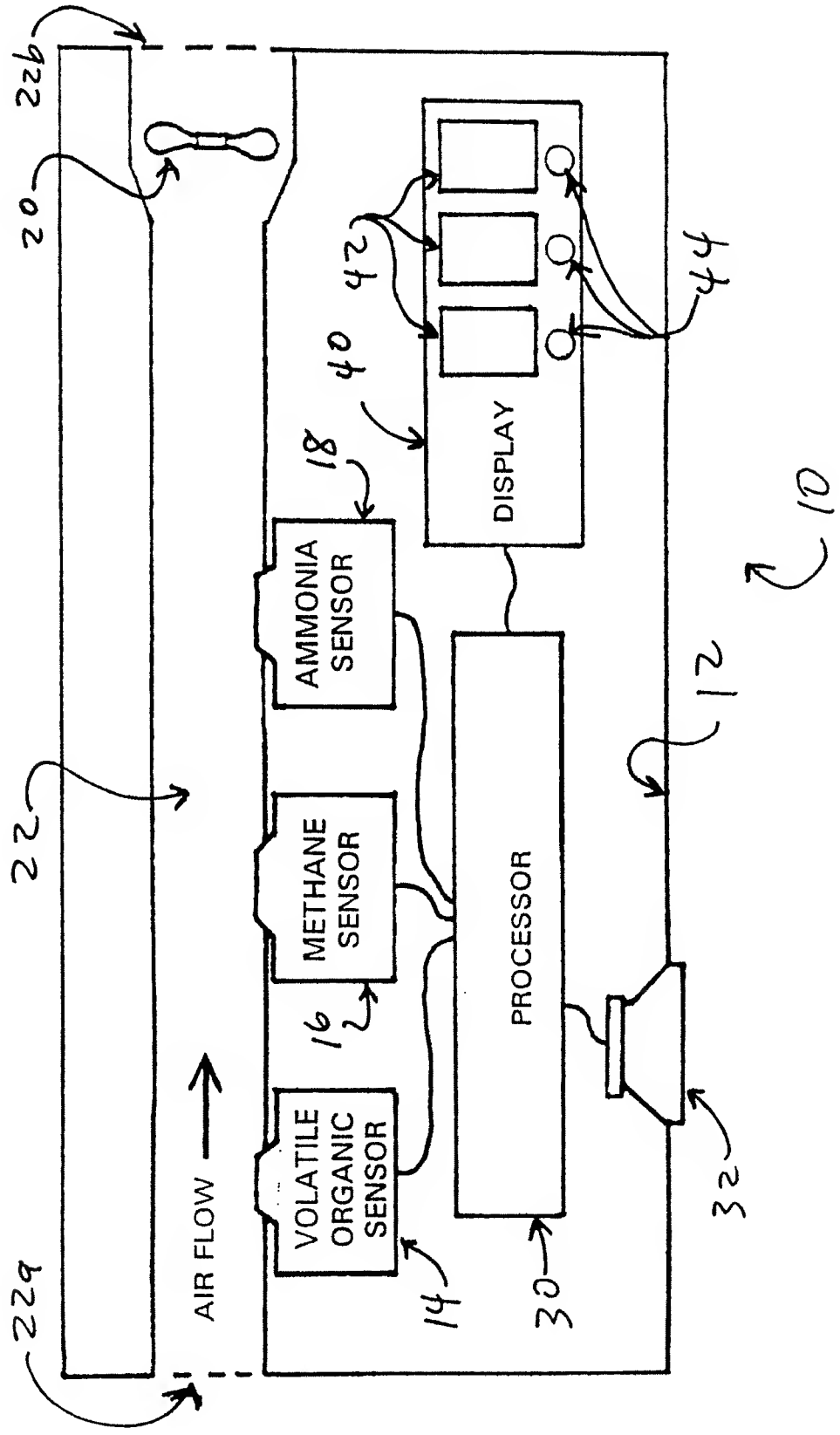
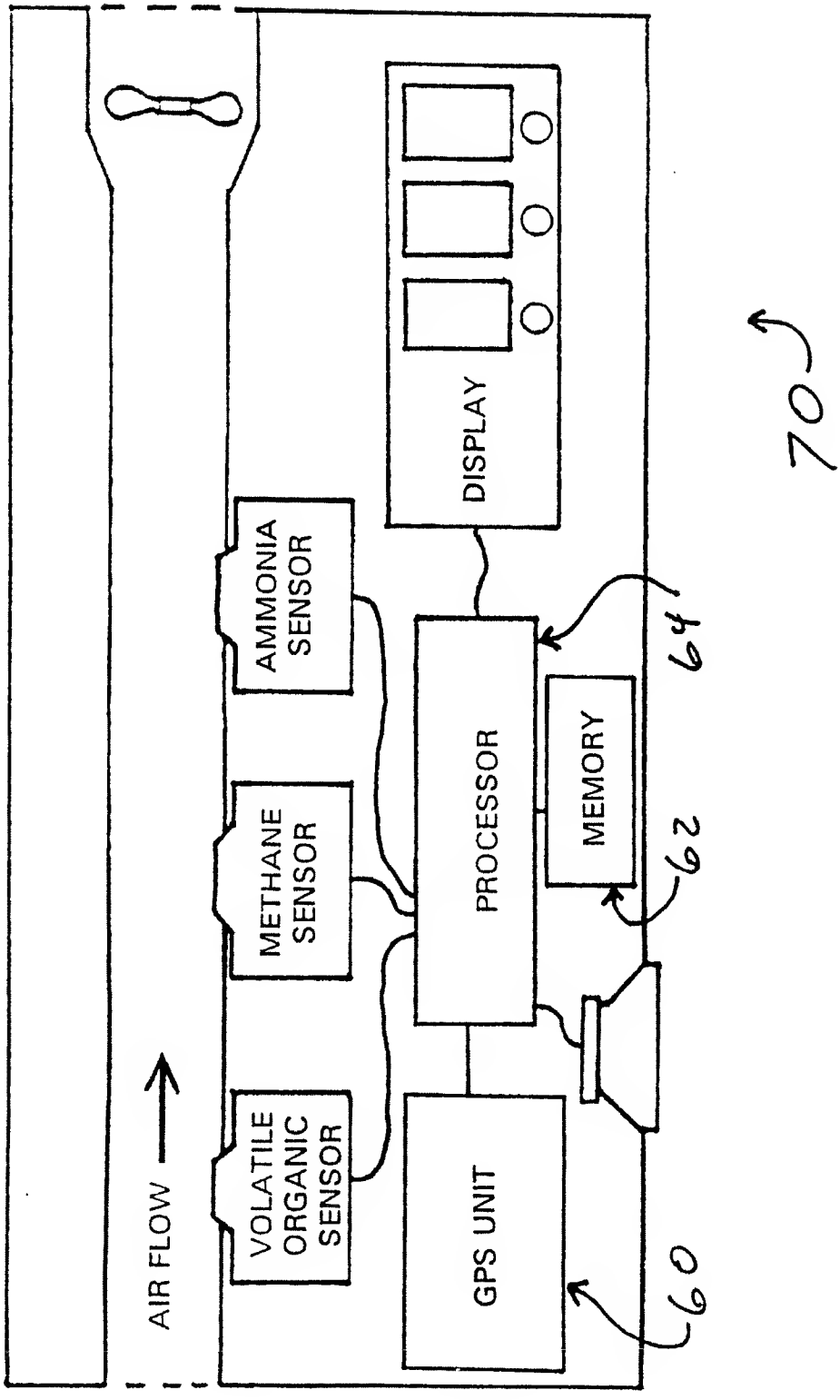
23. The method of claim 17, at least one ketone of a type which is generated during decomposition of human livers is detected by a chemical sensor.


22a
20
42
44
40
DISPLAY
18
AMMONIA SENSOR
10
12
22
METHANE SENSOR
16
PROCESSOR
32
AIR FLOW
VOLATILE ORGANIC SENSOR
14
30
22a


AIR FLOW
VOLATILE ORGANIC SENSOR
METHANE SENSOR
AMMONIA SENSOR
GPS UNIT
PROCESSOR
MEMORY
DISPLAY
60
62
64
70

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/25343

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : G01N 7/00, 33/00
US CL : 73/23.2; 436/141
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 73/23.2; 436/141

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS
seach terms: sensors, methane, ammonia, ketone, alarm, search & rescue, corpse, GPS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X ---- Y	US 4,410,632 A (DILLEY et al) 18 October 1983, col. 3, lines 36-39, 42-45; col. 4, lines 9-19; col. 5, lines 1-11; col. 6, lines 40-53; col. 7, lines 61-65; col. 8, lines 43-64; col. 10, lines 56-60, 65-68.	1-4, 7-8, 10-14, 16 ---------- 1-23
X ---- Y	US 4,847,783 A (GRACE et al) 11 July 1989, claims 1, 11, 13; Fig. 1; col. 2, line 40-col. 3, line29; col. 4, line 56-col. 5, line 3; col. 9, lines 57-69.	1-4, 6-7, 10-16 ---------- 1-23
Y, P	US 5,907,111 A (JOSTEN et al) 25 May 1999, abstract; col. 14, lines 9-19, 47-59; claims 1-3, 8, 9, 12.	9, 18

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

*	Special categories of cited documents	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 20 JANUARY 2000	Date of mailing of the international search report 10 FEB 2000
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer JOHN C. KIM Telephone No. (703) 308-0661

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/25343

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4,195,513 A (COHEN) 01 April 1980, Fig. 1; col. 1, lines 6-25; col.3, line 59- col. 4, line 4; col. 4, line 64-col. 5, line 35.	1-23
Y	US 5,801,297 A (MIFSUD et al) 01 September 1998, abstract; col. 12, lines 44-57; col. 13, line 30; claims 1, 9-10.	1-23
Y	US 5,588,398 A (ALLEN, II et al) 31 December 1996, abstract; claims 19, 22, 27.	19
A	US 4,600,557 A (SPITZ) 15 Jul. 1986, col. 3, lines 6-8.	